Traumatic Injuries to the Teeth

Course Date: 10/10
Expiration Date: 10/13

Objectives

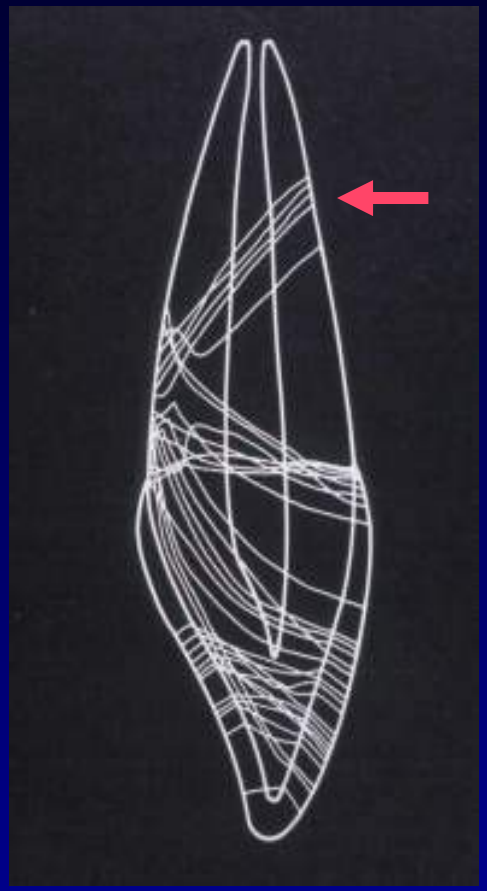
- Provide general information on the types of tooth trauma that may be encountered.
- Provide general information on the diagnosis and treatment of tooth trauma.

Traumatic Injuries to the Teeth

- Crown Fractures
- Crown-Root Fractures
- Root Fractures
- Luxation Injuries
- Avulsion

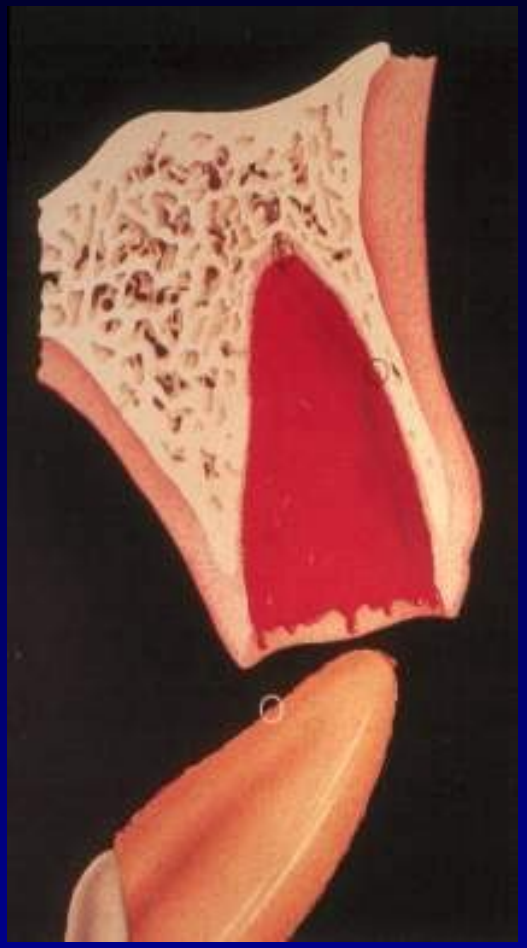
Traumatic Injuries to the Teeth

- Root Fracture Update



Traumatic Injuries to the Teeth

- Root Fracture Update
- Management of the Avulsed Tooth



Root Fracture Update

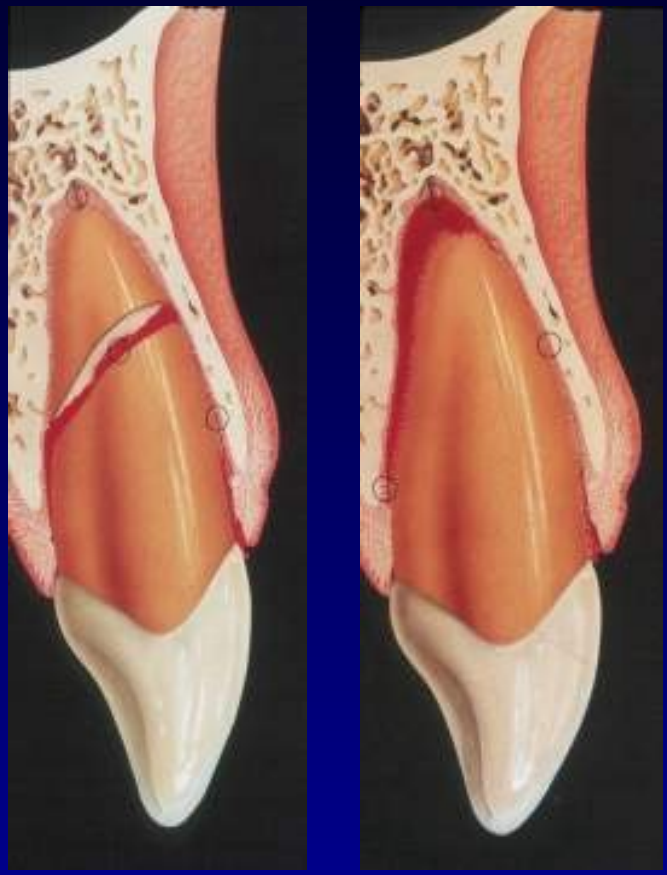
- Clinical examination
  - Tooth usually slightly extruded
  - Tooth frequently displaced lingually

Root Fracture Update

- Clinical examination
  - Tooth usually slightly extruded
  - Tooth frequently displaced lingually

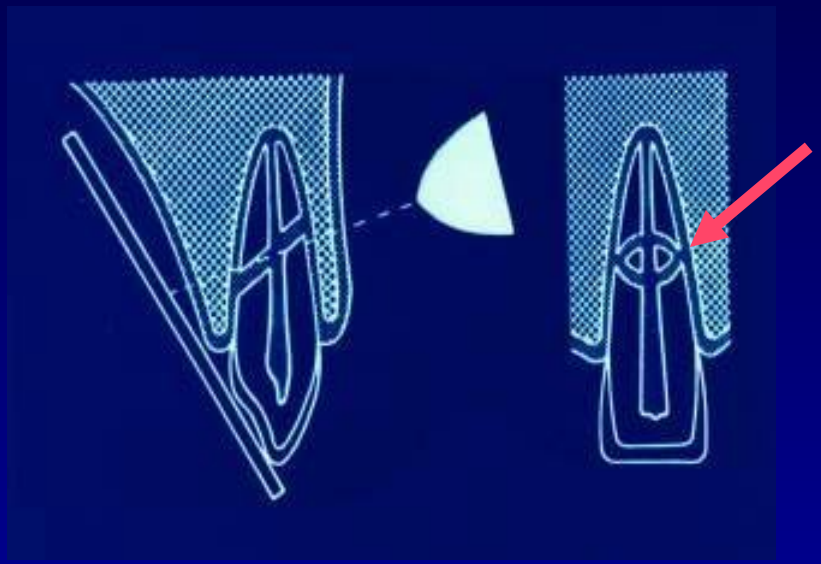
Root Fracture Update

- Clinical examination
  - Diagnosis entirely dependent upon radiographic examination



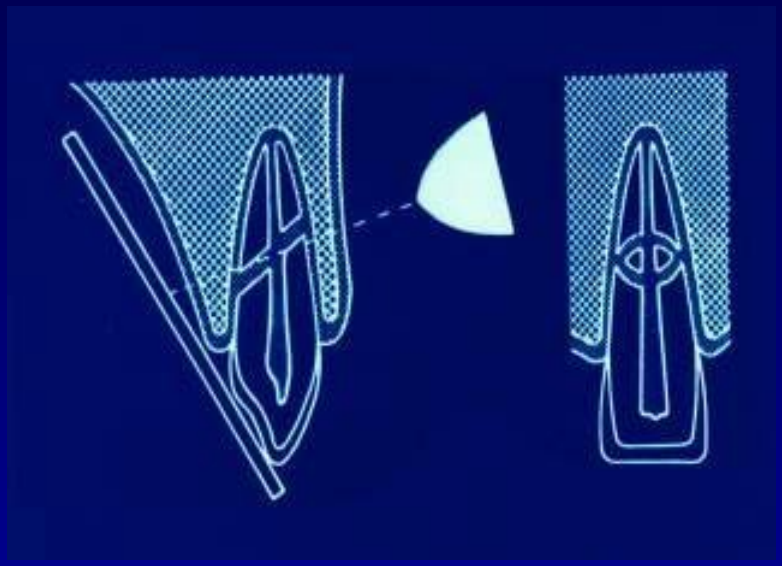
Emergency Management

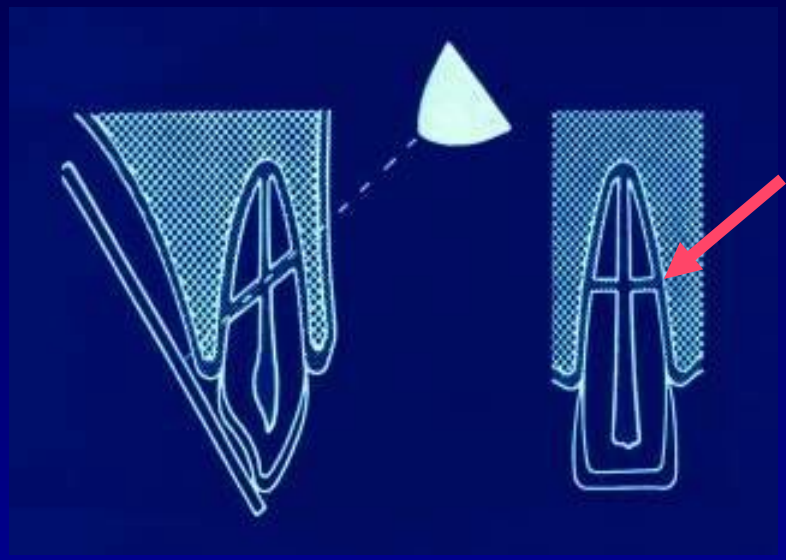
- Periapical radiographs
  - Standard XCP radiograph
  - Increased vertical angulation



Emergency Management

- Periapical radiographs
  - Standard XCP radiograph
  - Increased vertical angulation



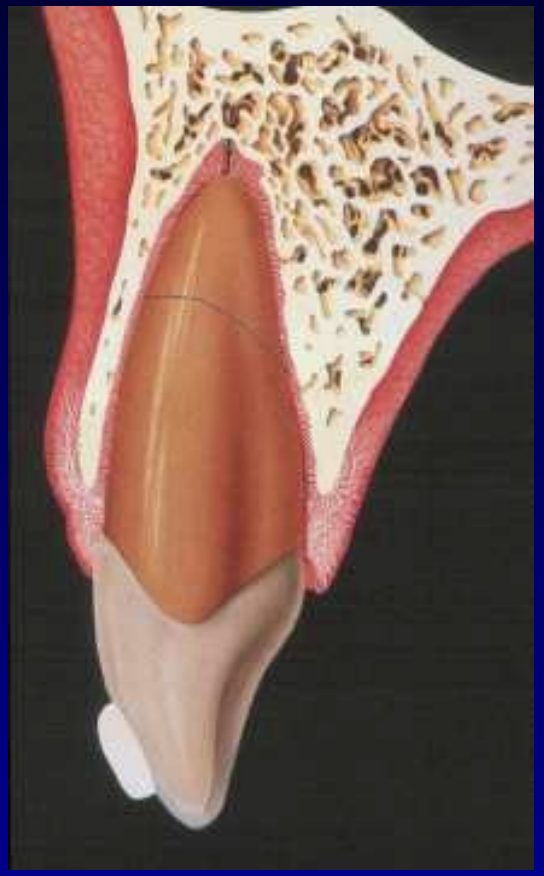


Emergency Management

- Reposition coronal fragment

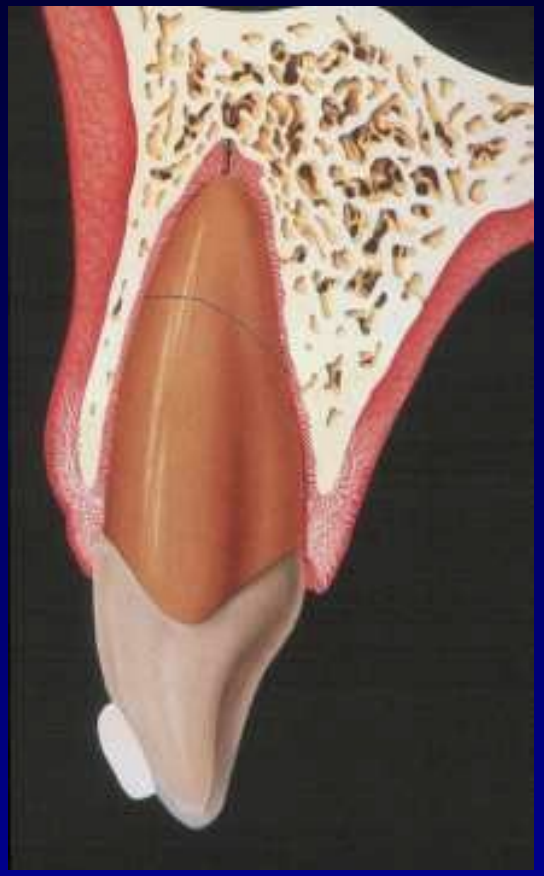
Emergency Management

- Previous recommendation
  - Rigid splinting for 2-3 months

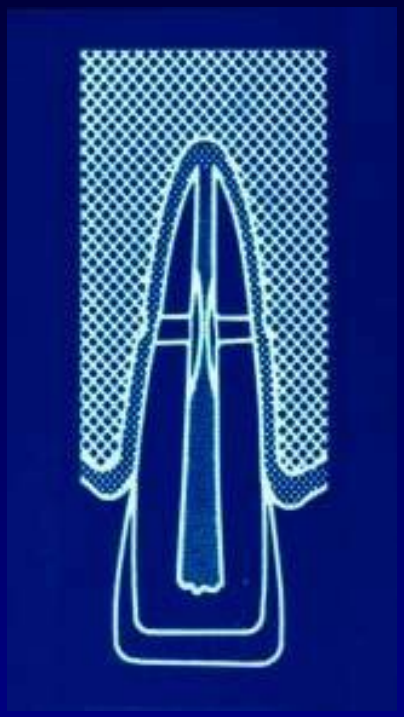
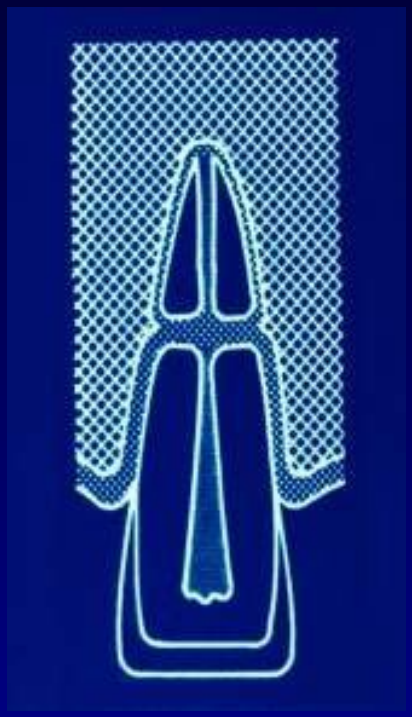
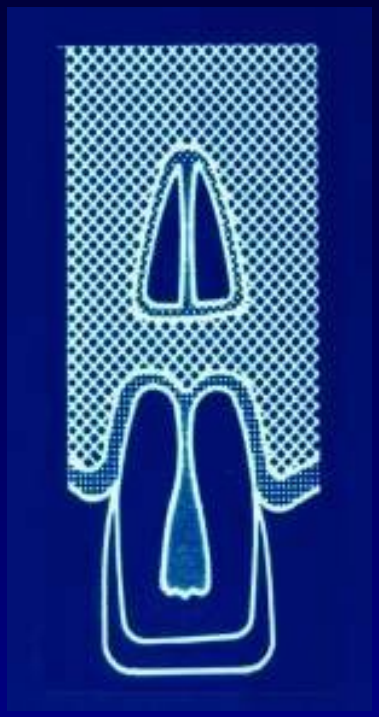
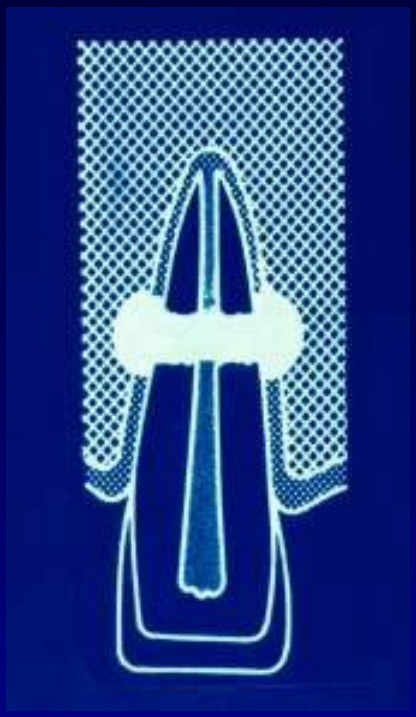


Emergency Management

- Previous recommendation
  - Rigid splinting for 2-3 months
- New recommendation
  - Splinting for 3 weeks

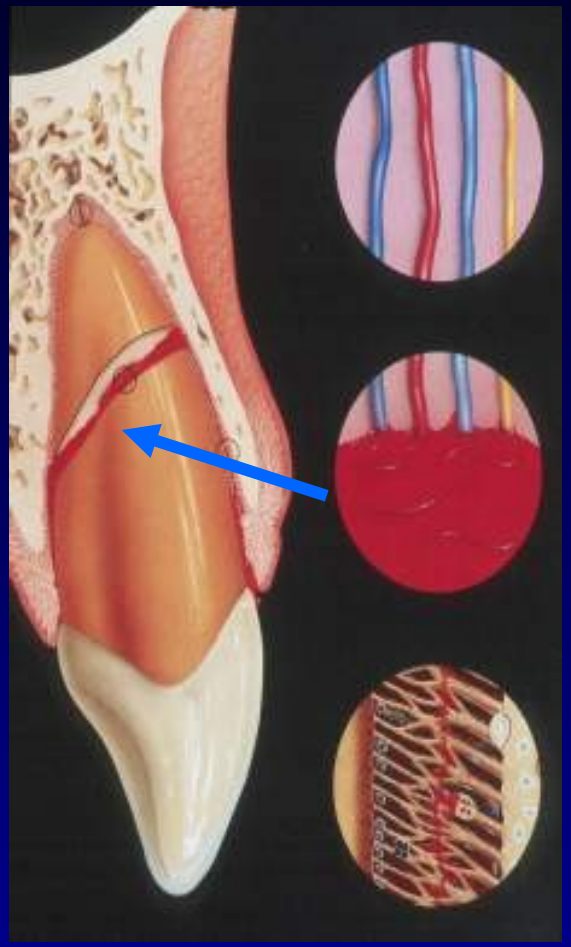


Root Fracture Healing

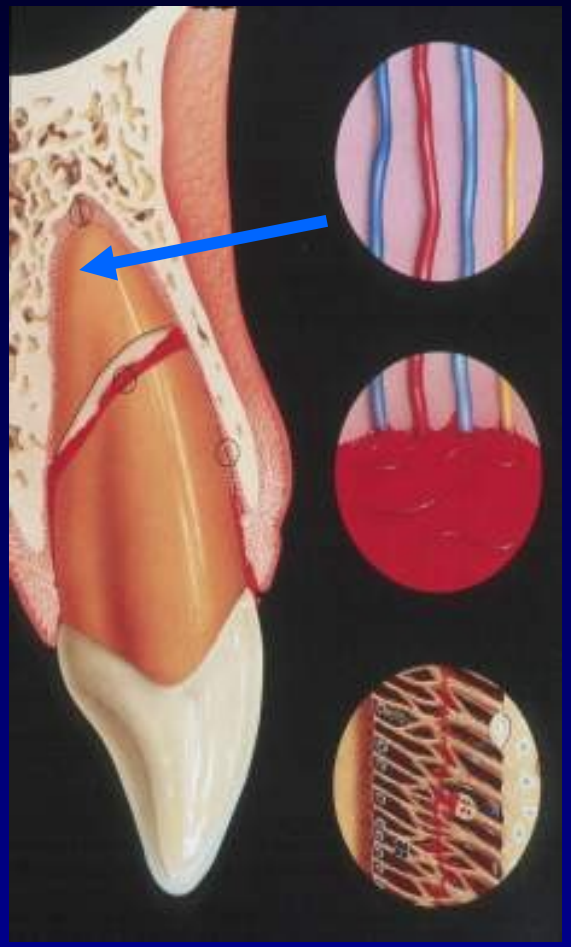
Root Fracture Complications

- Pulp necrosis
  - Coronal segment → 20 to 44%



Root Fracture Complications

- Pulp necrosis
  - Coronal segment → 20 to 44%
  - Apical segment → 0%



Root Fracture Complications

- Pulp necrosis
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Root Fracture Complications

- Pulp necrosis
  - Coronal segment → 20 to 44%
  - Apical segment → 0%
- Pulp canal obliteration → 69%

Root Fracture Complications

- Pulp necrosis
  - Coronal segment → 20 to 44%
  - Apical segment → 0%
- Pulp canal obliteration → 69%
- Root resorption → 60%

Root Fracture Treatment

- Summary
  - Reposition and splint for 3 weeks !!

Root Fracture Treatment

- Summary
  - Reposition and splint for 3 weeks !!
  - Monitor with pulp tests and radiographs

Root Fracture Treatment

- Summary
  - Reposition and splint for 3 weeks !!
  - Monitor with pulp tests and radiographs
  - Do not initiate endodontic treatment unless there are signs of pulp necrosis

Management of the Avulsed Tooth

Management of the Avulsed Tooth

- Overview
- Periodontal Ligament Responses
- Treatment Considerations
- Pulpal Prognosis/ Endodontic Rationale
- Treatment Regimen

Avulsed Permanent Teeth

- Incidence
  - 0.5% to 16% of traumatic injuries
- Main etiologic factors
  - Fights
  - Sports injuries
  - Automobile accidents

Avulsed Permanent Teeth

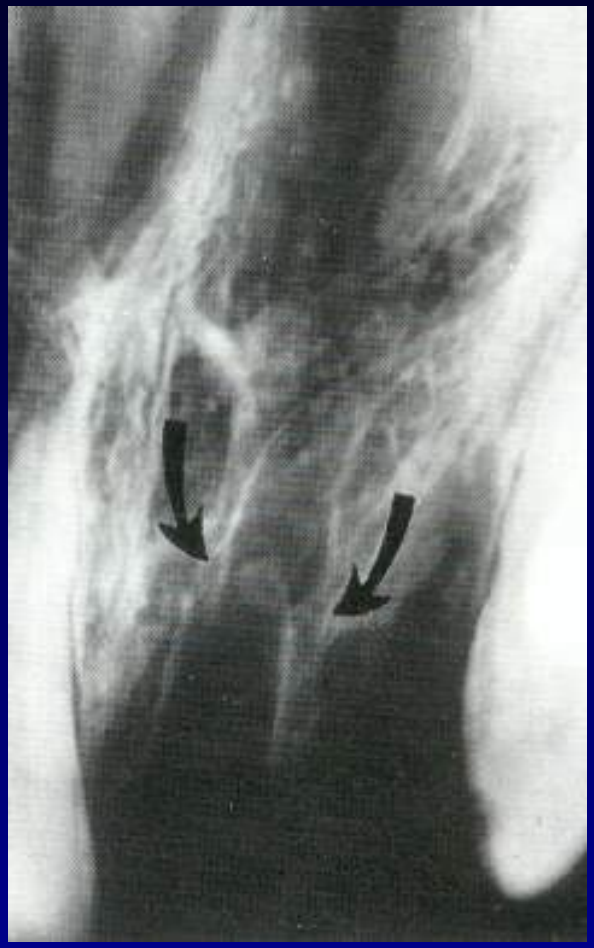
- Maxillary central incisor
  - Most commonly avulsed tooth
- Mandibular teeth
  - Seldom affected
- Most frequently involves a single tooth

Avulsed Permanent Teeth

- Most common age - 7 to 11
  - Permanent incisors erupting
  - Loosely structured PDL

Avulsed Permanent Teeth

- Associated injuries
  - Fracture of alveolar socket wall

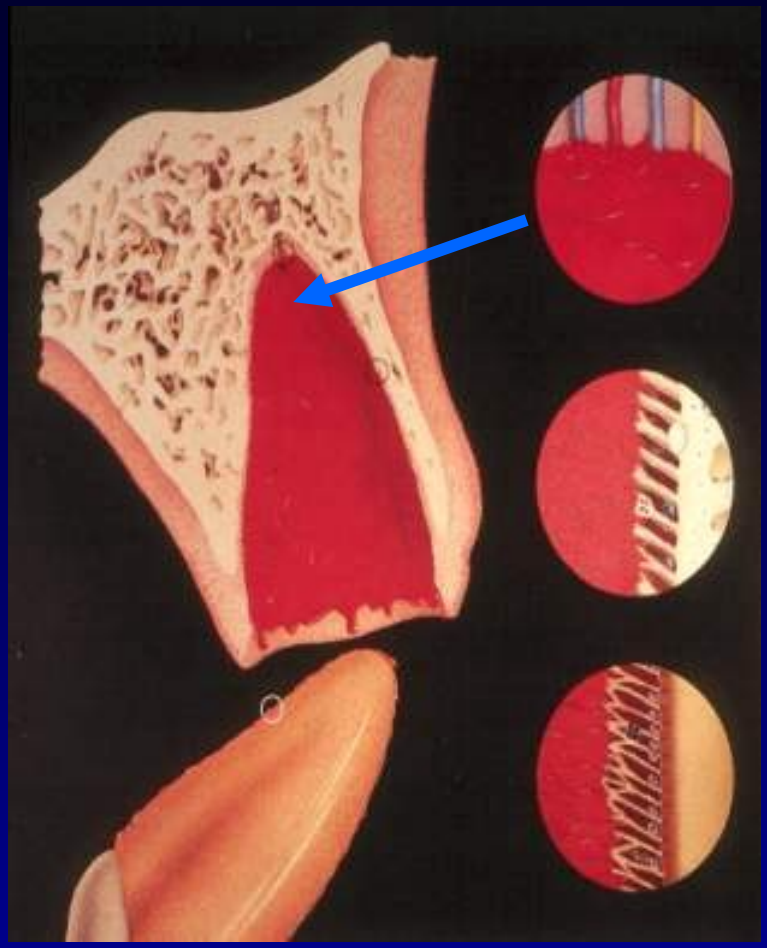


Avulsed Permanent Teeth

- Associated injuries
  - Fracture of alveolar socket wall
  - Injuries to the lips and gingiva

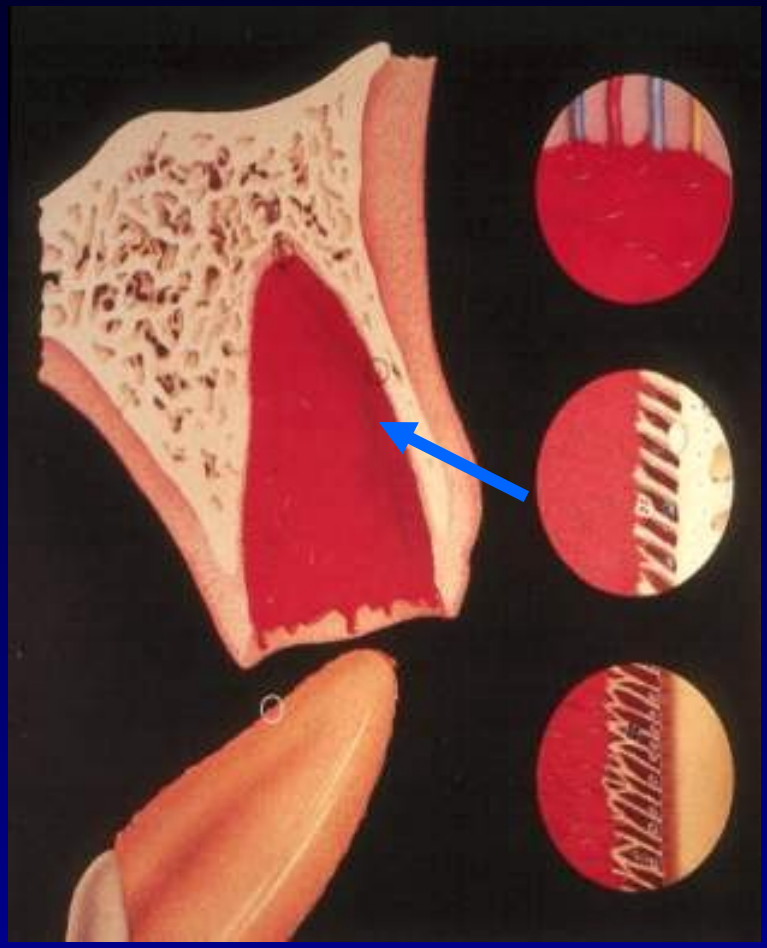
Management of the Avulsed Tooth

- What tissue should be our primary concern?
  - Pulp?



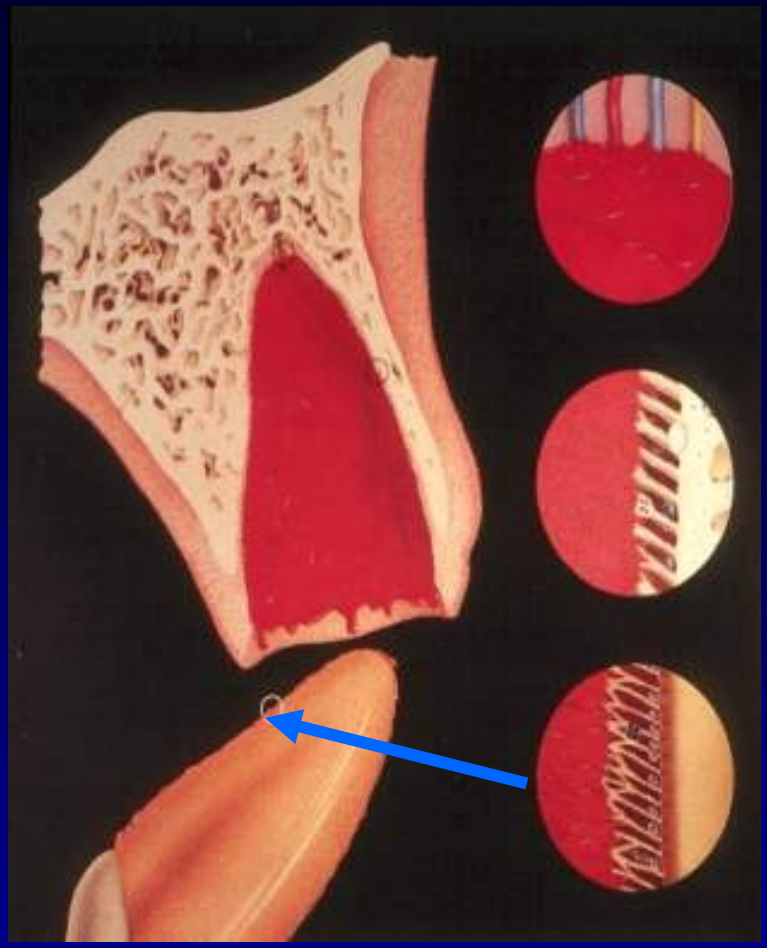
Management of the Avulsed Tooth

- What tissue should be our primary concern?
  - Pulp?
  - Socket?



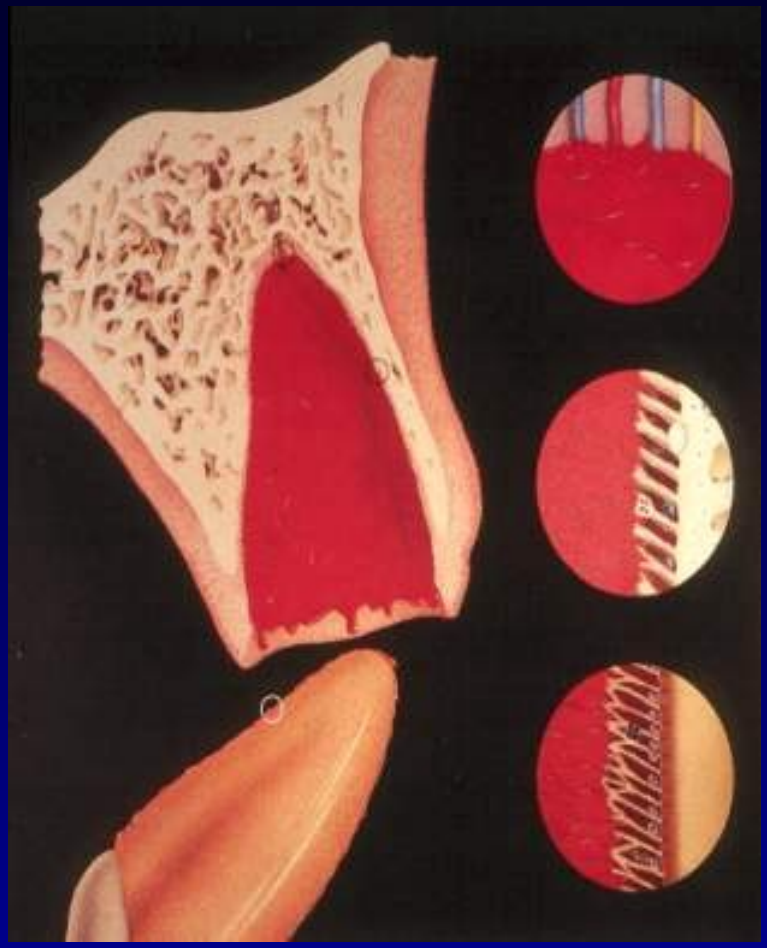
Management of the Avulsed Tooth

- What tissue should be our primary concern?
  - Pulp?
  - Socket?
  - PDL?



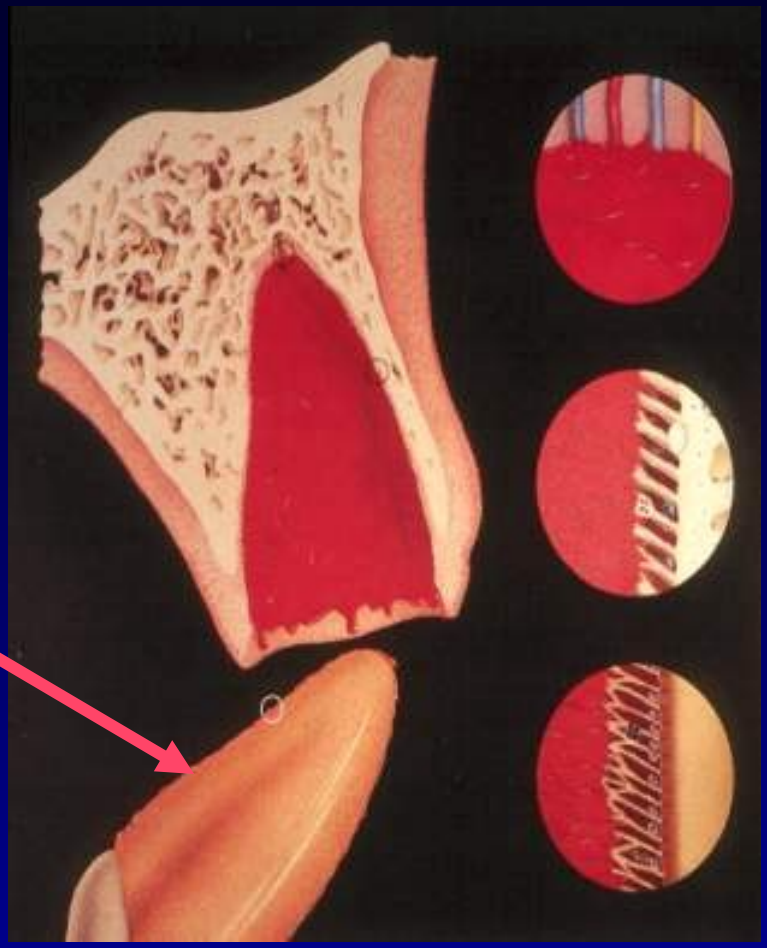
Management of the Avulsed Tooth

- Ultimate goal
  - PDL healing without root resorption



Management of the Avulsed Tooth

- Ultimate goal
  - PDL healing without root resorption
- Most critical factor
  - Maintaining an intact and viable PDL on the root surface



Periodontal Ligament Responses

- Surface Resorption
- Replacement Resorption (Ankylosis)
- Inflammatory Resorption

Andreasen JO, Hjorting-Hansen E.
Replantation of teeth II. Histological study of 22 replanted anterior teeth in humans.
Acta Odontol Scand 1966;24:287-306.

Periodontal Ligament Responses

- Surface resorption
  - Superficial resorption cavities
  - Mainly in cementum
  - Complete repair of PDL

Periodontal Ligament Responses

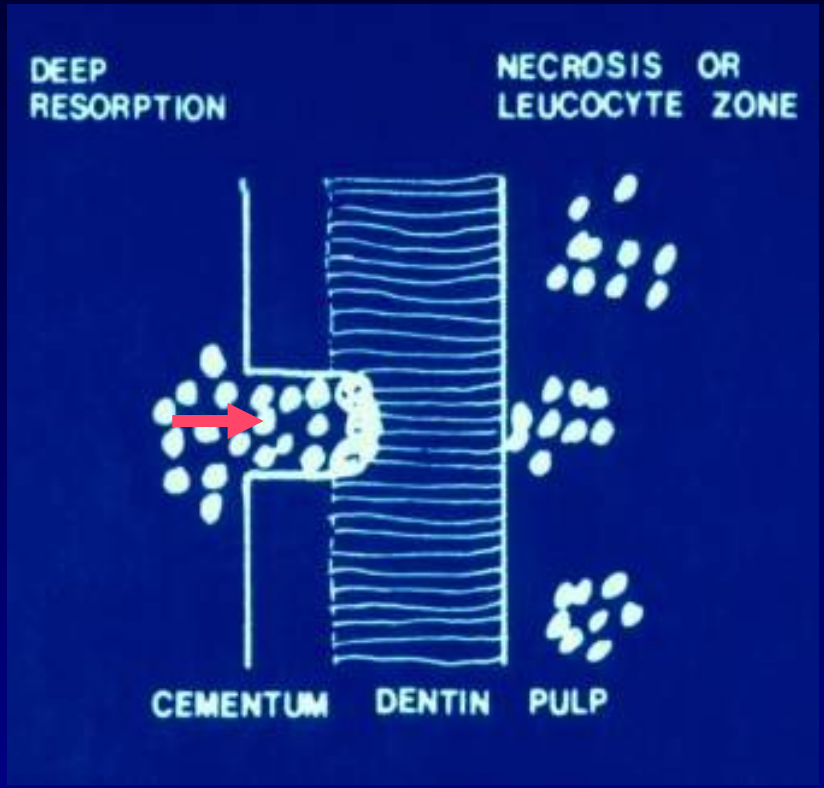
- Replacement resorption (Ankylosis)
  - Direct union of bone and root
  - Resorption of root - Replacement with bone
  - Direct result of loss of vital PDL

Periodontal Ligament Responses

- Inflammatory resorption
  - Resorption of cementum and dentin
  - Inflammatory reaction in the periodontal ligament

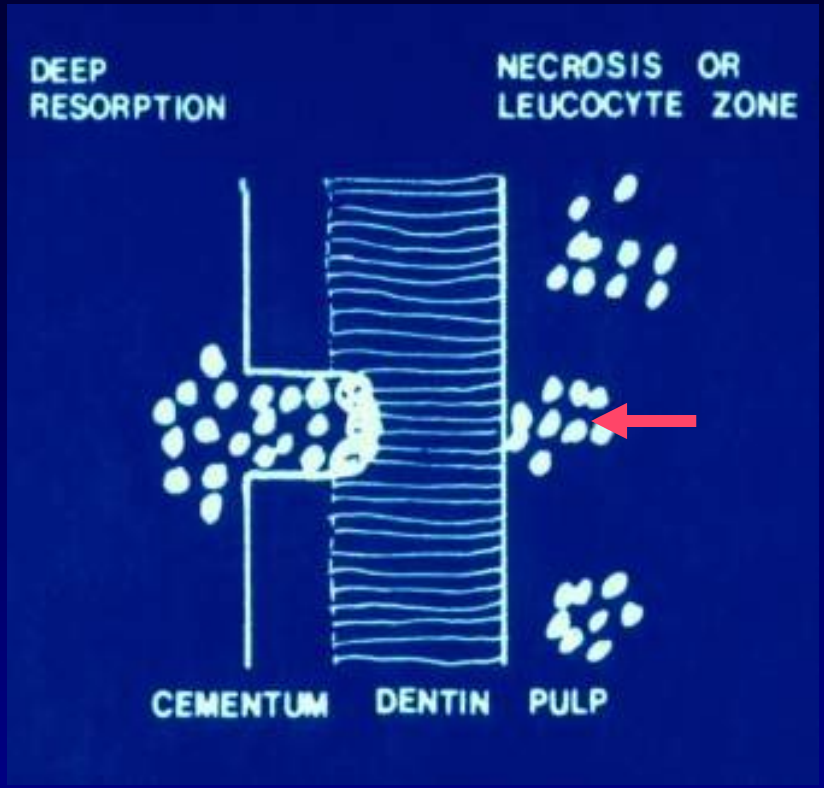
Etiology

- Inflammatory resorption
  - Surface resorption of cementum exposing dentinal tubules



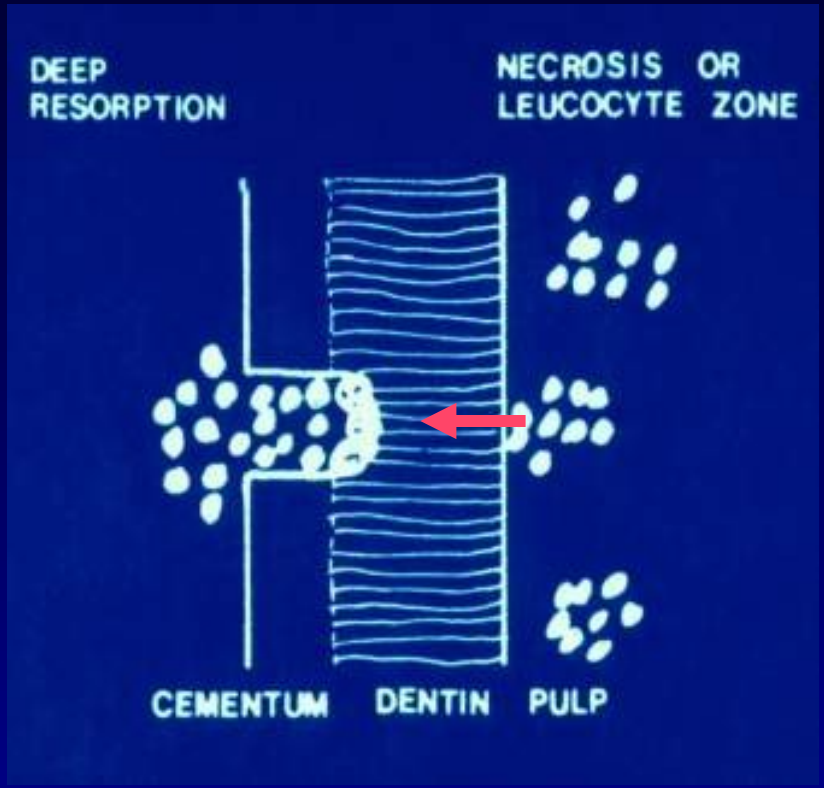
Etiology

- Inflammatory resorption
  - Surface resorption of cementum exposing dentinal tubules
  - Pulp necrosis



Etiology

- Inflammatory resorption
  - Surface resorption of cementum exposing dentinal tubules
  - Pulp necrosis
  - Toxic products from the pulp provoke an inflammatory response in the PDL



Periodontal Ligament Responses

- Surface resorption

Periodontal Ligament Responses

- Surface resorption
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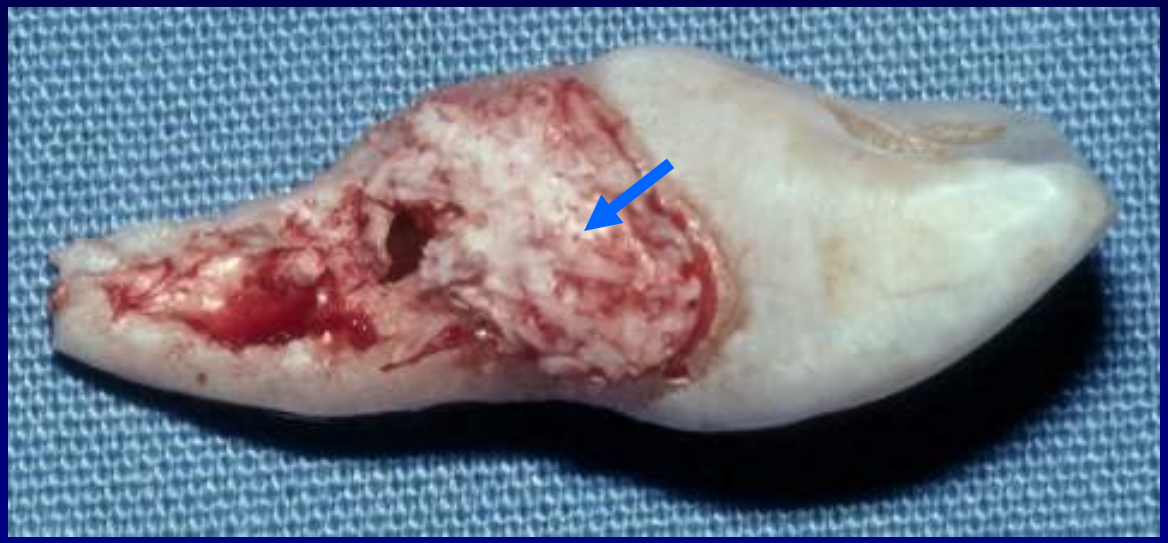


Periodontal Ligament Responses

- Surface resorption
- Replacement resorption (Ankylosis)
- Inflammatory resorption

Treatment Considerations

- Extraoral time
- Extraoral environment
- Root surface manipulation
- Management of the socket
- Stabilization

Extraoral Time

- Shorter time = Better prognosis
  - < 30 min → 10% resorption
  - > 90 min → 90% resorption

Andreasen JO, Hjorting-Hansen E.
Replantation of teeth I. Radiographic and clinical study of 110 human teeth replanted after accidental loss.
Acta Odontol Scand 1966;24:263-86.

Extraoral Time

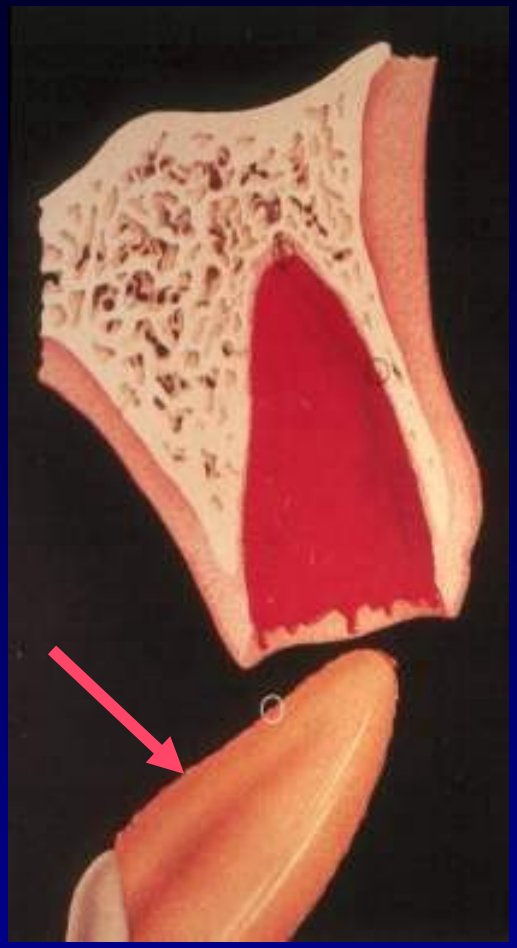
- Shorter time = Better prognosis*
  - < 30 min → 10% resorption
  - > 90 min → 90% resorption

*depending on storage medium

Andreasen JO, Hjorting-Hansen E.
Replantation of teeth I. Radiographic and clinical study of 110 human teeth replanted after accidental loss.
Acta Odontol Scand 1966;24:263-86.

Extraoral Environment

- Viability of PDL cells is critical



Storage Media

- Tap Water
- Dry
- Saliva
- Saline

} Poor results

media

Andreasen JO.

Effect of extra-alveolar period and storage media upon periodontal and pulpal healing after replantation of mature permanent incisors in monkeys.

Int J Oral Surg 1981;10:43-53.

Storage Media

- Tap Water
- Dry

} Poor results

- Saliva
- Saline

} Good protection for 2 hrs

Andreasen JO.

Effect of extra-alveolar period and storage media upon periodontal and pulpal healing after replantation of mature permanent incisors in monkeys.

Int J Oral Surg 1981;10:43-53.

Milk As A Storage Medium

- Physiologic osmolality
- Markedly fewer bacteria than saliva
- Readily available

Storage Media - Milk vs. Saliva

- Storage for 2 hrs
  - Periodontal healing almost as good as immediate replantation

Blomlof L, et al.

Storage of experimentally avulsed teeth in milk prior to replantation.

J Dent Res 1983;62:912-6.

Storage Media - Milk vs. Saliva

- Storage for 2 hrs
  - Periodontal healing almost as good as immediate replantation
- Storage for 6 hrs
  - Saliva → extensive replacement resorption
  - Milk → healing almost as good as immediate replant

Blomlof L, et al.

Storage of experimentally avulsed teeth in milk prior to replantation.

J Dent Res 1983;62:912-6.

Cell Culture Media

- Eagle’s Medium
- Hank’s Balanced Salt Solution

Hank's Balanced Salt Solution

- Proper pH and osmolality
- Reconstitutes depleted cellular metabolites
- Washes toxic breakdown products from the root surface

Organ Transplant Storage Media

- Viaspan
  - Dramatically prolongs the storage of human organs
  - Expensive
  - Not readily available

Storage Media Comparison

- Viaspan
  - Complete healing after 6 and 12 hrs
  - Good for extended storage periods (72 and 96 hrs)

Trope M, Friedman S.

Periodontal healing of replanted dog teeth stored in Viaspan, milk and Hank's balanced salt solution.

Endod Dent Traumatol 1992;8:183-8.

Storage Media Comparison

- Viaspan
  - Complete healing after 6 and 12 hrs
  - Good for extended storage periods (72 and 96 hrs)
- Hank's balanced salt solution
  - Healing results similar to Viaspan

Trope M, Friedman S.

Periodontal healing of replanted dog teeth stored in Viaspan, milk and Hank's balanced salt solution.

Endod Dent Traumatol 1992;8:183-188.

Recommended Storage Media

1. Socket (immediate replantation)
2. Cell culture medium
3. Milk
4. Physiologic saline
5. Saliva

Root Surface Manipulation

- Attempt to retain PDL cell viability
  - Do not curette root surface
  - Avoid caustic chemicals

Van Hassel HJ, Oswald RJ, Harrington GW.
Replantation 2. The role of the periodontal ligament.
J Endodon 1980;6:506-508.

Root Surface Manipulation

- **Extraoral dry time** determines handling

Root Surface Manipulation

- Extraoral **dry** time ≤ 1 hr
  - PDL healing is still possible
  - Handling recommendations
    - » Keep root moist
    - » Do not handle root surfa
    - » Gentle debridement

Root Surface Manipulation

- Extraoral **dry** time > 1 hr
  - Loss of PDL cell viability inevitable
  - Treatment recommendations
    - » Remove tissue tags
    - » Soak in accepted dental fluoride solution for 20 min

Fluoride Treatment

- 1.0-2.4% topical fluoride solution
  - Sodium fluoride (Andreasen)
  - Stannous fluoride (Krasner)
- 20 minute soak

Management of the Socket

- Remove contaminated coagulum in socket
  - Irrigate with sterile saline

Management of the Socket

- Examine socket → ***If fracture is evident***
  - Reposition fractured bone with a blunt instrument

Management of the Socket

- Replant using light digital pressure

Stabilization

- Splint
  - Definition → a rigid or flexible device used to support, protect, or immobilize teeth, preventing further injury
  - Types
    - Acid etch composite
    - Cross-suture

Acid Etch Composite Splints

- Interproximal composite

Acid Etch Composite Splints

- Composite with arch wire

Acid Etch Composite Splints

- Composite with monofilament nylon

Acid Etch Composite Splints

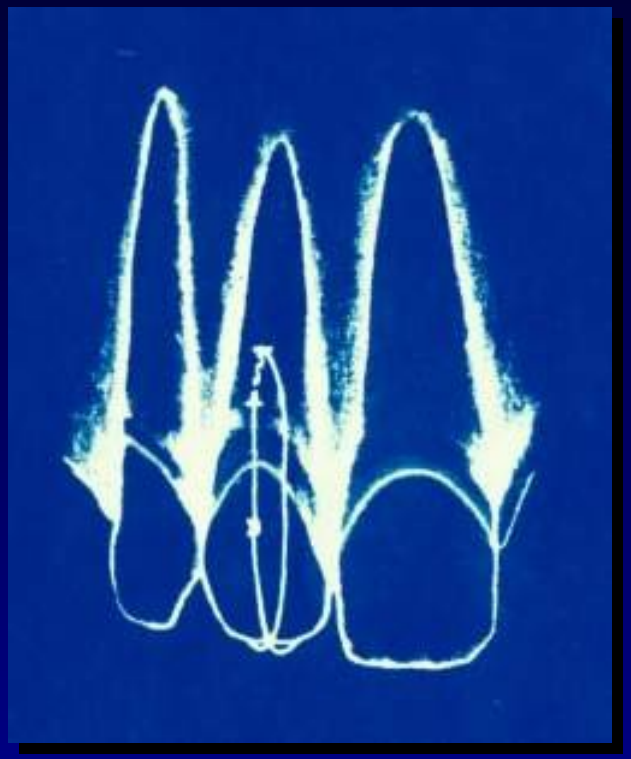
- Functional Splint
  - 20-30 lb monofilament nylon
  - Bonded with composite
  - Allows physiologic movement

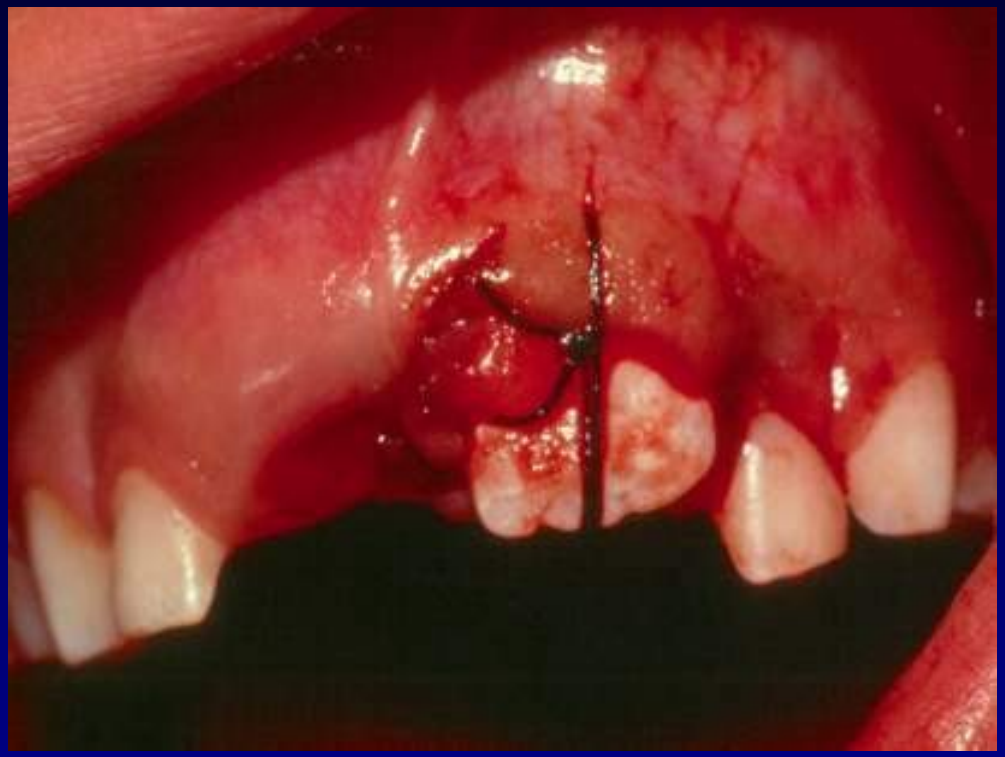
Antrim DD, Ostrowski JS.
A functional splint for traumatized teeth.
J Endodon 1982;8:328-331.

Cross-Suture Splint

- Indications
  - No adjacent teeth to splint to
  - Unmanageable traumatized children

Cross-Suture Splint





Splinting Time

- Effect of splinting tim
  - 7 days
  - 30 days

Nasjleti CE, Castelli WA, Caffesse RG. The effects of different splinting times on replantation of teeth in monkeys. Oral Surg 1982;53:557-566.

Splinting Time

- Recommended time
  - **7 to 10 days**

Nasjleti CE, Castelli WA, Caffesse RG. The effects of different splinting times on replantation of teeth in monkeys. Oral Surg 1982;53:557-566.

Pulpal Prognosis

- Stage of root development
- Dry storage time
- Storage media
- Antibiotics

Stage of Root Development

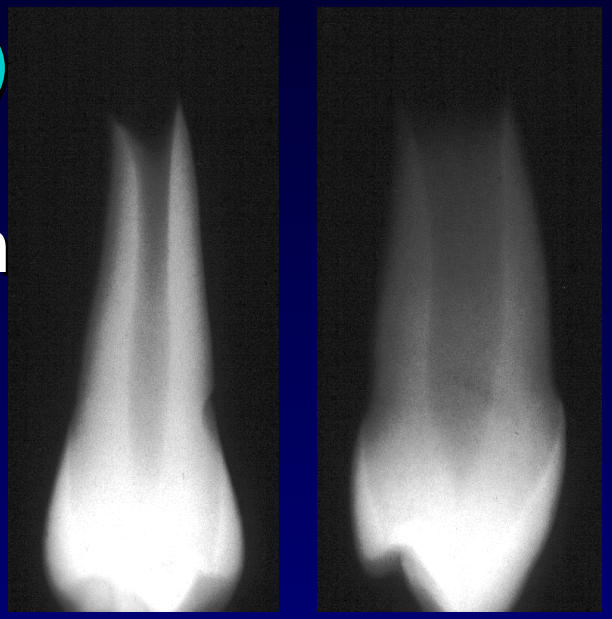
- Mature roots (≤ 1.0 mm)
  - Revascularization 0%

Kling M, et al. Endod Dent Traumatol 1986;2:83-89.

Andreasen JO, et al. Endod Dent Traumatol 1995;11:51-8.

Stage of Root Development

- Mature roots (≤ 1.0 mm)
  - Revascularization 0%
- Immature roots (> 1.0 m
  - Revascularization 18-34%

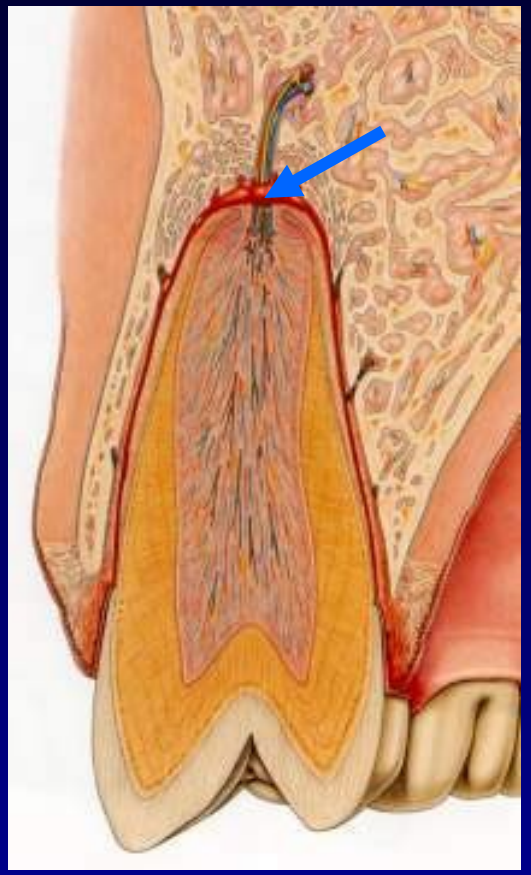


Kling M, et al. Endod Dent Traumatol 1986;2:83-89.

Andreasen JO, et al. Endod Dent Traumatol 1995;11:51-8.

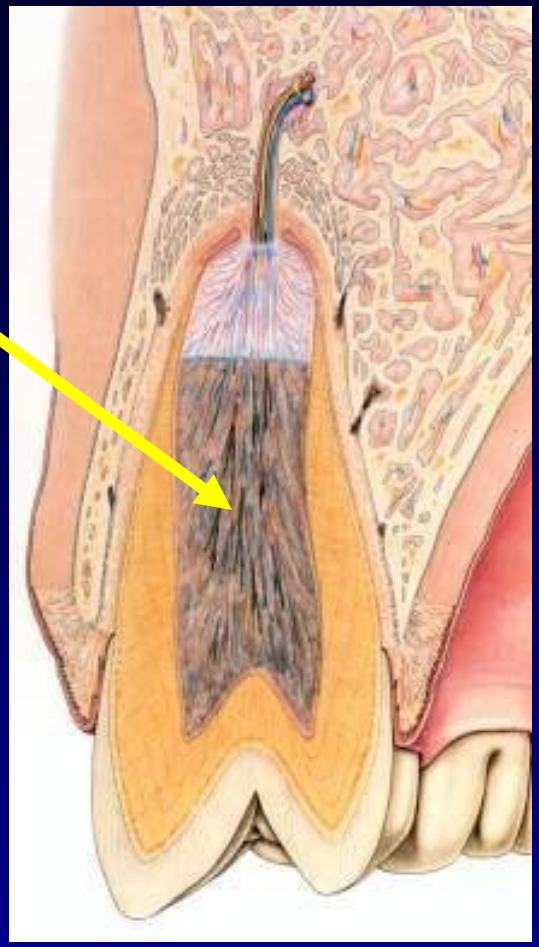
Revascularization

- Loss of blood supply to pulp



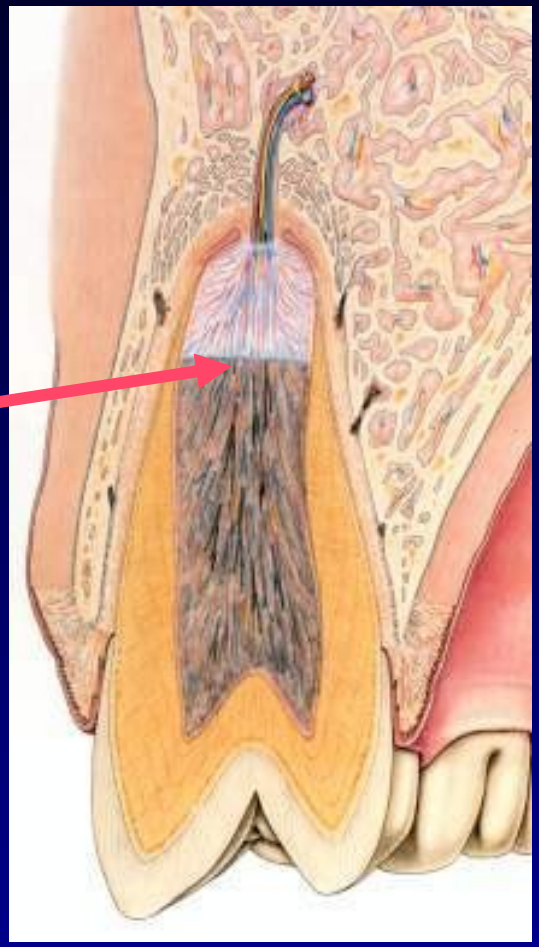
Revascularization – Day 4

- Coronal pulp
  - Extensive ischemic injury



Revascularization – Day 4

- Coronal pulp
  - Extensive ischemic injury
- Apical pulp
  - Initial revascularization

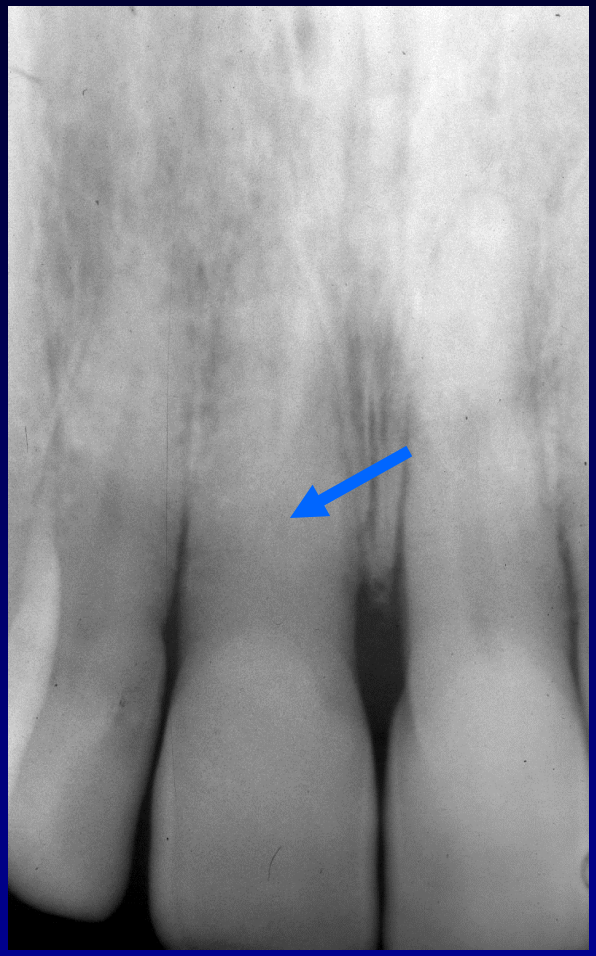


Revascularization – 4 Weeks

- Pulp status
  - Revascularization
  - Reinnervation
  - New odontoblastic layer

Revascularization

- Typical sequela
  - Pulp canal obliteration



Dry Storage Time

- As dry storage time increases

Pulp survival decreases

Andreasen JO, Borum MK, Jacobsen HL, Andreasen FM.
Endod Dent Traumatol 1995;11;59-68.

Storage Media

- Nonphysiologic storage
  - Minimal chance of pulp revascularization

Andreasen JO, Borum MK, Jacobsen HL, Andreasen FM.

Endod Dent Traumatol 1995;11;59-68.

Storage Media

- Nonphysiologic storage
  - Minimal chance of pulp revascularization
- Physiologic storage
  - HBSS, milk, saline, saliva
  - Improved chance of pulp revascularization

Andreasen JO, Borum MK, Jacobsen HL, Andreasen FM.

Endod Dent Traumatol 1995;11;59-68.

Pulpal Prognosis - Antibiotics

- Systemic antibiotics
  - Pulp revascularization is **not increased**

Cvek M, Cleaton-Jones P, Austin J, Lowni J, Kling M, Fatti P.

Endod Dent Traumatol 1990;6:157-169.

Pulpal Prognosis - Antibiotics

- Systemic antibiotics
  - Pulp revascularization is not increased
- Topical antibiotics
  - **Beneficial effect**

Cvek M, Cleaton-Jones P, Austin J, Kling M, Lowni J, Fatti P.

Endod Dent Traumatol 1990;6:170-176.

Pulpal Prognosis - Antibiotics

- Topical Doxycycline
  - Decreased microorganisms in pulpal lumen
  - Increased pulp revascularization

Cvek M, Cleaton-Jones P, Austin J, Kling M, Lowni J, Fatti P.

Endod Dent Traumatol 1990;6:170-176.

Pulpal Prognosis - Antibiotics

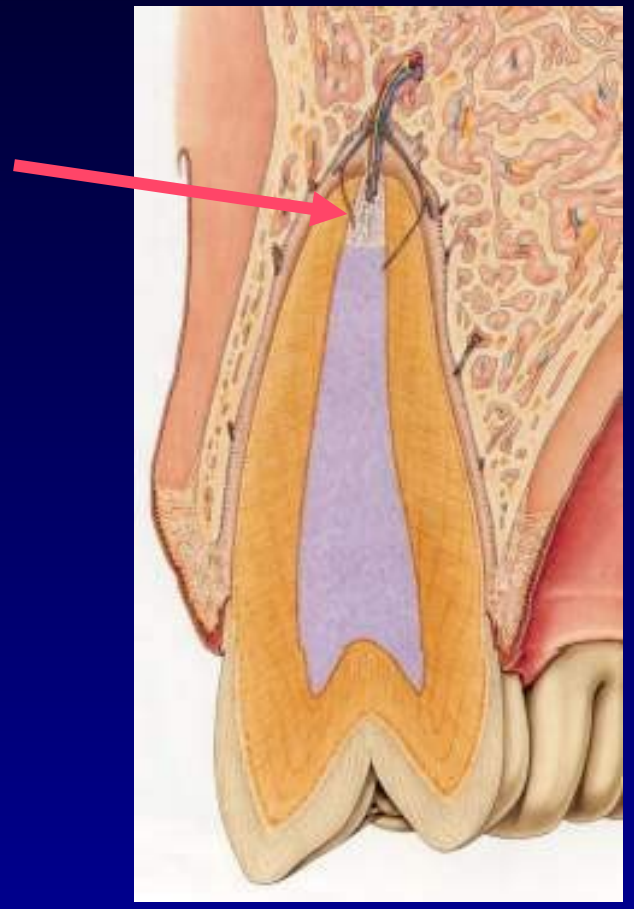
- Recommendation
  - Topical Doxycycline
    - » 1 mg in 20 ml physiologic saline
    - » 5 minute soak

Cvek M, Cleaton-Jones P, Austin J, Kling M, Lowni J, Fatti P.

Endod Dent Traumatol 1990;6:170-176.

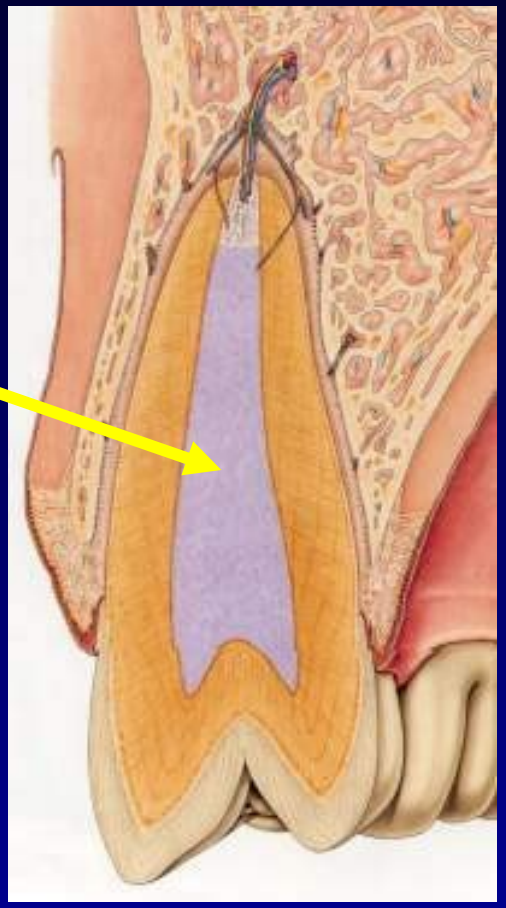
Endodontic Rationale

- Mature root - 4 weeks
  - Very limited revascularization



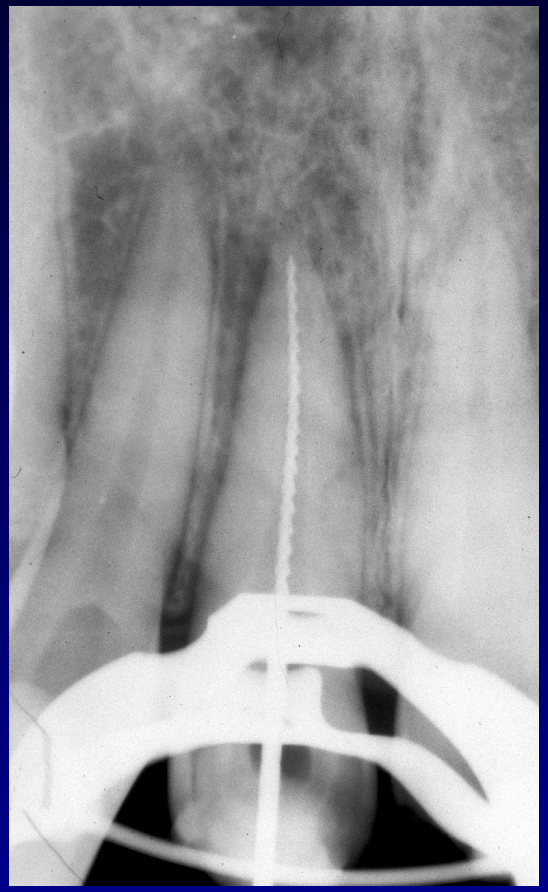
Endodontic Rationale

- Mature root - 4 weeks
  - Very limited revascularization
  - Ischemic coronal pulp with **great risk of infection !!!**



Endodontic Rationale – Mature Root

- Pulpectomy → 7-14 days



Endodontic Rationale – Mature Root

- Calcium hydroxide placement

Endodontic Rationale – Mature Root

- Calcium hydroxide
  - Antibacterial
  - Increases pH in dentin
  - Favors mineralization over resorption

Tronstad L, Andreasen JO, et al.
pH changes in dental tissues after root canal filling with calcium hydroxide.
J Endodon 1981;7:17-21.

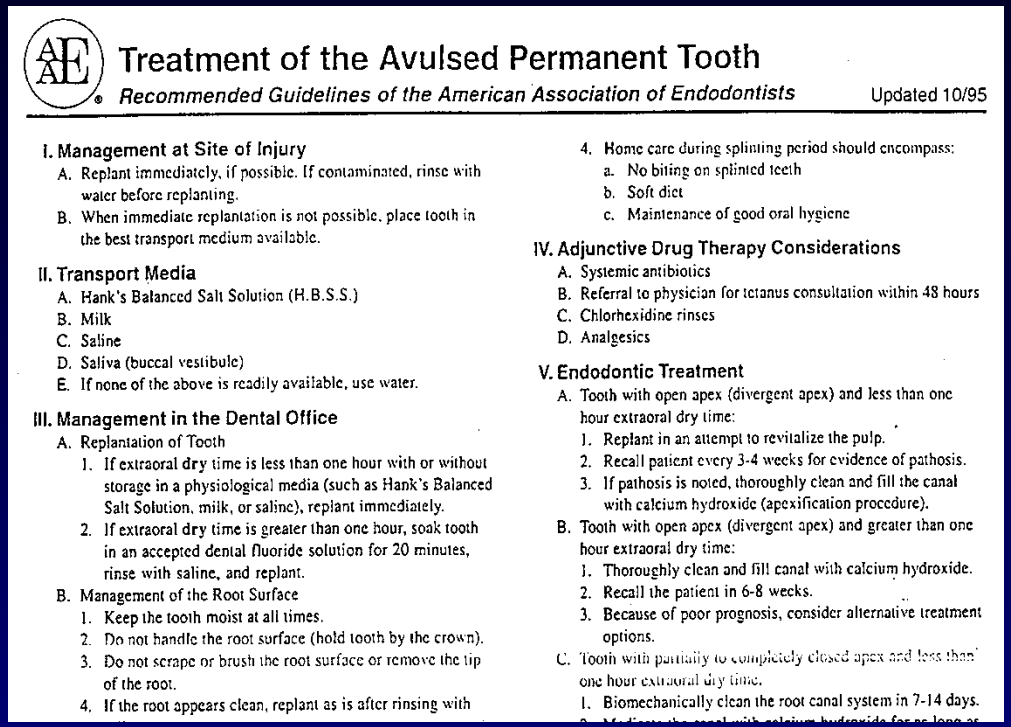
Endodontic Rationale – Mature Root

- Treatment recommendation
  - $Ca(OH)_2$ therapy for as long as practical, usually 6-12 months

Treatment of the Avulsed Permanent Tooth.

Recommended Guidelines of the American Association of Endodontists, 1995.

Specific Treatment Regimen



Treatment of the Avulsed Permanent Tooth

Recommended Guidelines of the American Association of Endodontists Updated 10/95

I. Management at Site of Injury

A. Replant immediately, if possible. If contaminated, rinse with water before replanting.
B. When immediate replantation is not possible, place tooth in the best transport medium available.

II. Transport Media

A. Hank's Balanced Salt Solution (H.B.S.S.)
B. Milk
C. Saline
D. Saliva (buccal vestibule)
E. If none of the above is readily available, use water.

III. Management in the Dental Office

A. Replantation of Tooth
   1. If extraoral dry time is less than one hour with or without storage in a physiological media (such as Hank's Balanced Salt Solution, milk, or saline), replant immediately.
   2. If extraoral dry time is greater than one hour, soak tooth in an accepted dental fluoride solution for 20 minutes, rinse with saline, and replant.
B. Management of the Root Surface
   1. Keep the tooth moist at all times.
   2. Do not handle the root surface (hold tooth by the crown).
   3. Do not scrape or brush the root surface or remove the tip of the root.
   4. If the root appears clean, replant as is after rinsing with
   4. Home care during splinting period should encompass:
      a. No biting on splinted teeth
      b. Soft diet
      c. Maintenance of good oral hygiene

IV. Adjunctive Drug Therapy Considerations

A. Systemic antibiotics
B. Referral to physician for tetanus consultation within 48 hours
C. Chlorhexidine rinses
D. Analgesics

V. Endodontic Treatment

A. Tooth with open apex (divergent apex) and less than one hour extraoral dry time:
   1. Replant in an attempt to revitalize the pulp.
   2. Recall patient every 3-4 weeks for evidence of pathosis.
   3. If pathosis is noted, thoroughly clean and fill the canal with calcium hydroxide (apexification procedure).
B. Tooth with open apex (divergent apex) and greater than one hour extraoral dry time:
   1. Thoroughly clean and fill canal with calcium hydroxide.
   2. Recall the patient in 6-8 weeks.
   3. Because of poor prognosis, consider alternative treatment options.
C. Tooth with partially to completely closed apex and less than one hour extraoral dry time.
   1. Biomechanically clean the root canal system in 7-14 days.

Treatment of the Avulsed Permanent Tooth.
Recommended Guidelines of the American Association of Endodontists, 1995.

Specific Treatment Regimen

Root Development

- Closed apex
- Open apex

*Extraoral **Dry** Time*

- One hour or less
- More than one hour

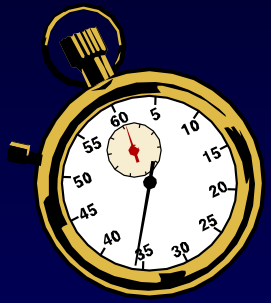
Treatment of the Avulsed Permanent Tooth.

Recommended Guidelines of the American Association of Endodontists, 1995.

Treatment Flowchart

Extraoral **Dry** Time

≤ 1 hr



> 1 hr

Apex Maturity

Closed
Pulpectomy 7-14 days

Open
Observe

Open or Closed
Pulpectomy 7-14 days
Option: Extraoral RCT

Emergency Treatment

- Replantation technique
  - Local anesthetic, if necessary
  - Radiograph to verify position
  - Check occlusion
  - Physiologic splint

Emergency Treatment

- Additional Considerations
  - Analgesics

Emergency Treatment

- Additional Considerations
  - Analgesics
  - Chlorhexidine

Emergency Treatment

- Additional Considerations
  - Analgesics
  - Chlorhexidine
  - Tetanus
    - » Refer to physician for tetanus prophylaxis prn

Rothstein RJ, Baker FJ.
Tetanus: Prevention and treatment.
J Am Med Assoc 1978;240:675-676.

Emergency Treatment

- Additional Considerations
  - Analgesics
  - Chlorhexidine
  - Tetanus
  - Antibiotics

Antibiotics

- Penicillin
  - 500 mg qid for 4-7 days

Andreasen JO.
Atlas of replantation and transplantation of teeth.
Philadelphia: W.B. Saunders Co., 1992;57-92.

Antibiotics

- Tetracycline vs. amoxicillin → *in a replacement resorption model*
  - Tetracycline had better anti-resorptive properties

Sae-Lim V, Wang CY, Choi GW, Trope M.

The effect of systemic tetracycline on resorption of dried replanted dogs' teeth.

Endod Dent Traumatol 1998;14:127-132.

Antibiotics

- Tetracycline vs. amoxicillin → *in an inflammatory root resorption model*
  - Tetracycline had better anti-bacterial properties

Sae-Lim V, Wang CY, Trope M.

Effect of systemic tetracycline and amoxicillin on inflammatory root resorption of replanted dogs' teeth.

Endod Dent Traumatol 1998;14:216-220.

Antibiotics

- Recommendation
  - "Tetracycline could be considered as an alternative to amoxicillin after avulsion injuries."

Sae-Lim V, Wang CY, Trope M.

Effect of systemic tetracycline and amoxicillin on inflammatory root resorption of replanted dogs teeth.

Endod Dent Traumatol 1998;14:216-220.

Tetracycline Use In Young Children

- Tetracycline staining
  - Not a problem since avulsed maxillary anteriors have already erupted and are not susceptible to staining
  - At worst, posterior teeth might be stained
    - » Remote possibility with 7-10 day prescription

Sae-Lim V, Wang CY, Trope M.

Effect of systemic tetracycline and amoxicillin on inflammatory root resorption of replanted dogs' teeth.

Endod Dent Traumatol 1998;14:216-220.

Avulsion Sequelae

- Closed Apex
- Extraoral dry time 1 hour or less

Avulsion Sequelae

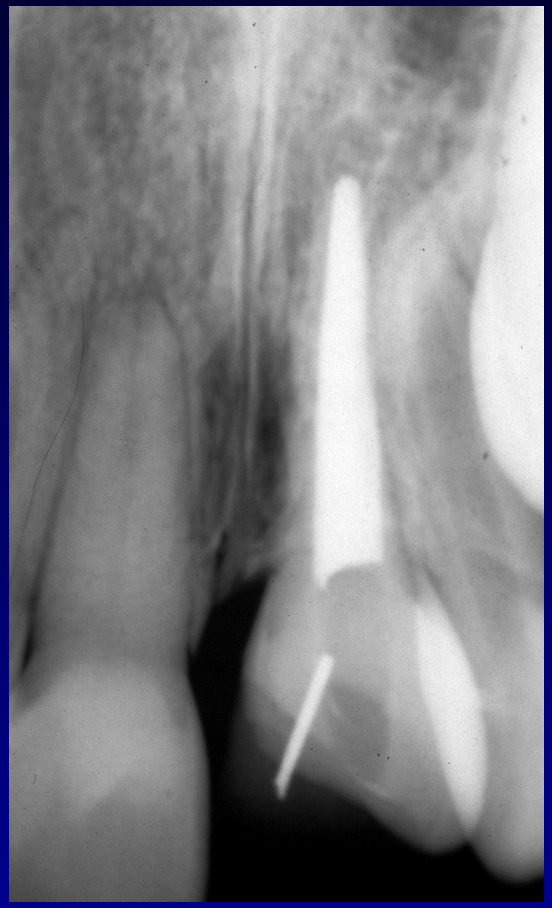
- Closed Apex
- Extraoral dry time more than 1 hour

Avulsion Sequelae

- Open Apex
- Extraoral dry time 1 hour or less

Avulsion Sequelae

- Open Apex
- Extraoral dry time more than 1 hour



Avulsion Management

- Be prepared -
  Dental Trauma Kit
- Immerse tooth in a physiologic storage medium to “buy time”
- Determine extraoral dry time
- Follow AAE Guidelines

References/Additional Resources

- The Recommended Guidelines of the American Association of Endodontists for the Treatment of Traumatic Dental Injuries. 2004 American Association of Endodontists 211 E. Chicago Ave., Suite 1100, Chicago, IL 60611-2691 Revised 10/04.

- Andreasen JO, Andreason FM, Anderson L. *Textbook and Color Atlas of Traumatic Injuries to the Teeth*, 4th edition. Ames: Blackwell Publishing, 2007.